



Continued Investigation into the Interactions of Saline Drainage Water on Crop Tolerance to Boron

Stephen Grattan and Andre Läuchli
Department of Land Air and Water Resources
University of California, Davis

Catherine Grieve, Jim Poss, and Don Suarez
USDA-ARS George E. Brown, Jr. Salinity Laboratory

Research with broccoli showed significant salinity-boron, salinity-pH, boron-pH and salinity-boron-pH interactions with respect to fresh weight, total biomass, head yield and water use efficiency. Salinity and boron can reduce emergence but effects are crop and variety specific.

An earlier salinity-boron interaction study with broccoli showed that salinity, regardless of the ionic composition, reduced boron's detrimental effect. Both stresses were damaging but their adverse effects were not additive. However, pH, a factor known to influence boron uptake, was not a variable. Therefore another greenhouse experiment was conducted in 2005-06, using broccoli grown in an elaborate sand tank system at the USDA-ARS, George E. Brown, Jr. Salinity Laboratory, to determine the interactive effects of salinity, boron and pH on broccoli (*Brassica oleracea* L., botrytis group, cv Seminis PX511018) performance including growth, yield, injury, and ion relations.

The irrigation treatments were prepared by adding various salts to modified half-strength nutrient solution to develop synthetic drainage water with a chemical composition characteristic of that found in the San Joaquin Valley. Five salinity levels (2.0, 5.0, 8.0, 11.0 and 14.0 dS/m) were tested at 2 boron concentrations (1.0 and 21 mg/L) under slightly acidic conditions (pH 6) and slightly basic conditions (pH 8). The experimental design was a 5x2x2 factorial with three replications.

ANOVA showed significant interactions of salinity-boron, salinity-pH, boron-pH and salinity-boron-pH with respect to fresh weight, total biomass, yield and water use efficiency. These interactions will be detailed in a model analysis but the overall finding from all of the interactions are that the individual effects of salinity, boron concentration, and pH are not simply additive. With regard to fresh fruit yield, increased salinity reduced yield but high boron added to treatments when the pH was maintained near pH 6 was not detrimental. However at pH 8, 21 mg/L B was extremely detrimental at low and high salinities. Interestingly, at moderate salinity levels (EC 5 – 11 dS/m) high boron did not further decrease yield. Therefore moderate levels of salinity (concentrations likely exposed to broccoli grown in rotation in reuse systems) protect that plant from boron toxicity under slightly basic conditions. Data on ion relations are still being processed.

A subsequent study was conducted in the sand tanks to determine the effects of salinity (2, 5, 8, 11 and 14 dS/m) and boron (1, 11, 21 and 31 mg/L) on cotton emergence. This is important since most experiments impose salinity and boron

treatments after the plants are established and cotton stands in the field have been adversely affected by drainage water applied the previous season. Six cotton varieties, including both Pima and Acala types, responded differently. For some varieties, salinity and boron decreased the percent emergence after two weeks while for others, either salinity or boron (not both) reduced emergence. Interestingly, for one Acala variety (6100), boron additions up to 31 mg/L significantly increased emergence at the two higher salinity levels. For this variety, unlike the others, there was a significant salinity-B interaction.

The emergence of six vegetable crops under similar treatments were also evaluated. Increased boron from 1 to 31 mg/L only decreased the emergence of cantaloupe seedlings. The other 5 vegetables tested were unaffected. Neither broccoli nor lettuce was impacted by increased salinity to the highest level (12.5 dS/m). The emergence of cantaloupe, tomato, corn and cucumber seedling, on the other hand, were reduced 45 to 65% at the highest salinity level. This effect was much greater than those cotton varieties affected by salinity.

Professional Presentations

Grattan, Steve, Catherine Grieve, Jim Poss, Don Suarez, Tim Smith and Andre Lauchli. Can broccoli tolerate higher concentrations of boron under saline conditions? World Congress of Soil Science. Philadelphia, PA July 10-14, 2006

Collaborative Efforts

This research project is a collaborative effort between the University of California at Davis and the USDA-ARS George E. Brown, Jr. Salinity Laboratory.

For further information please contact:

Stephen R. Grattan
srgrattan@ucdavis.edu
(530) 752-4618

Catherine M. Grieve
cgrieve@usssl.ars.usda.gov
(951) 369-4836